FOREST PEST MANAGEMENT

BIOLOGICAL EVALUATION
R2-97-03

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ABSTRACT

The Douglas-fir beetle outbreak on the Shoshone National Forest is evaluated for the eighth consecutive year. Adult emergence in 1996 showed a single peak. Overwintering brood in 1996 were used to predict population levels for 1997. Brood levels declined from 1995 but 81% of the overwintering brood are adults. Damage levels (number of trees killed) was at its lowest point in the last 7 years, a 4.5 fold decline from 1995. Brood counts indicate a steady or slight increase in beetle populations; however, in most areas suitable host trees are becoming scarce.

Management alternatives include salvage and sanitation, tree baiting, silvicultural treatments, and no action. Recommended actions vary depending on individual areas.

INTRODUCTION

This is the eighth yearly evaluation in a series documenting an outbreak of the Dougls-fir beetle (DFB), *Dendroctonus pseudotsugae* Hopkins (Coleoptera: Scolytidae), on the Clarks Fork and Wapiti Ranger Districts of the Shoshone National Forest. The seven previous evaluations have tracked the yearly progression of this outbreak (Pasek 1990, 1991; Pasek and Schaupp 1992, 1995; Schaupp 1993; Schaupp and Pasek 1995).

The outbreak began when the Clover Mist Fire of Yellowstone National Park entered parts of the Clarks Fork district generally south of U.S. Highway 212 and Wyoming Route 296. This area, which contains both managed stands and wilderness, contained a large number of older, large diameter Douglas-fir, a number of which received some degree of scorch.

In 1990, both scorched and green Douglas-fir trees were attacked by the Douglas-fir beetle. DFB has continued to spread through stands containing large diameter trees along the Clarks Fork River and into Sunlight Basin. Annual tree mortality since 1990 has ranged from 1,000 to 5,600 trees. The low figure was from this past year, 1996, and represents a substantial decline in mortality (4.5 times) from 1995.

Overall brood production and percent of brood overwintering as adults has fluctuated (Pasek and Schaupp 1995). However, yearly tree mortality remained relatively stable between 1992 and 1995, before dropping in 1996.

This evaluation was conducted to monitor and predict DFB population changes and provide management alternatives for the DFB on the Shoshone National Forest in 1996 and 1997. To accomplish this, adult emergence information was gathered during the summer of 1996, and fall brood count data were collected for predicting 1997 levels.

METHODS

In early May 1996, wire-mesh screen cages (1' x 2') were attached to the north sides of 12 standing, Douglas-fir that were infested by the '95-'96 DFB generation. Cages were located at three sites (four cages at each site): along Wyoming Route 296 by Sugarloaf, behind the state transportation compound and gravel pile along 296, and west of Beem Gulch along Sunlight Road. Adult DFB that emerged under these cages were collected approximately weekly beginning May 19 through September 29, 1996. Collected DFB were stored in alcohol and transported to the Rapid City Service Center office, where they were counted by gender.

Additionally, one cage each at Deadman Creek and by Sugarloaf that had been attached in early May 1995 (i.e., on trees infested by the '94-'95 DFB generation) were checked in the same manner. The objective was to collect information about emergence following prolonged development of up to 2 years.

On 22-23 October 1996, bark samples (6" x 6") were removed at a height of 5-7 feet from the north and south sides of each of 29 Douglas-fir trees currently infested by DFB. Sample sites were located at the state transportation compound, and at two sites along Sunlight Road. Diameter at breast height (DBH) was recorded for each sample tree. Live DFB and DFB natural enemies dislodged from the bark sample during removal were identified, counted, and discarded. The number of gallery starts was also counted. Bark samples were stored in plastic bags and transported to the Rapid City Service Center office, where they were examined. Total inches of egg gallery were measured for each bark sample. Phloem was shaved with a knife to locate all remaining live insects in each sample. Numbers of live DFB brood were tallied by life stage and DFB natural enemies were counted. Means and standard deviations by sample site were calculated for all variables measured.

Bark samples were also removed from the caged trees (n = 12) using the same methods. Samples were taken from the north side (beneath cages) and the south side (opposite cages) of all trees caged in May 1995. Bark samples were handled and examined as described above.

RESULTS AND DISCUSSION

DFB emergence in 1996 began in late May and was complete by August 11, with the exception of two beetles collected on September 8 (Figure 1). There was a single peak of emergence from early June to late June. This peak started about a week earlier than in 1995, but was in the same general timeframe as in earlier years (Figure 2). There was no second emergence peak in 1996. The single peak in 1996 corresponds with the 1995 overwintering brood comprised of mostly callow adults (Pasek 1996).

There was adult emergence from both trees caged in 1995 ('94-'95 generation). This also occurred in 1994 and 1995, and is likely from DFB that have extended their life cycle to 2 years (Pasek and Schaupp 1995). A total of 18 beetles were collected from the two trees caged in 1995, one from one tree and 17 from the other.

From trees that were attacked in 1995 and caged in 1996, a total of 321 beetles were collected in the cages. This averages 11.5 adult DFB per square foot of bark surface using the total DFB collected per cage over the entire trapping period. The range of total DFB collected per cage was 0-164 adults or 0-82 per square foot. Mean emergence by site was 30 DFB per sq. ft. at the Gravel Pile, 2.6 DFB per sq. ft. along Sunlight Road, and 1.3 DFB per sq. ft. at Sugarloaf. There were more males than females emerging (55% males to 45% females) for those beetles whose sex could be determined.

Population trends for a generation can be estimated by dividing the density of emerging beetles by twice the density of gallery starts (attacks), assuming a pair of beetles initiates each gallery start. When the ratio of emergence to attack exceeds one, the population is increasing and when the ratio is less than one the population is decreasing. For the '96 DFB generation, the population trend was 0.8, indicating the population is starting to decline. This is in contrast to the stable or increasing population that was predicted (Pasek 1996). The causes of the decline are not known for sure, but it is likely that the beetles are starting to run out of suitable host material. This decline in beetle activity was also noted in an aerial survey conducted in July 1996. In 1995, about 4,500 trees were killed in this area; in 1996, the number of trees killed dropped to about 1,000, a 4.5-fold decrease in tree mortality. Overall, there have been about 24,600 trees killed (data from yearly aerial surveys) over the 7 years of the outbreak.

Overwintering brood density of the '96-'97 DFB generation averaged 9.1 per 36 sq. in. bark sample or 36.4 per sq. ft. of bark surface (Table 1). Brood production declined in 1996 compared to 1995 and 1994 (Figure 3). The site at Sunlight West had the highest brood production, with almost twice the brood compared to Sunlight East. Production at the Gravel Pile was in between the other two.

Of the overwintering brood, 81% were new or callow adults. Most of the rest of the brood were larvae (17%), only 2% were pupae. This is an increase in the percentage of brood overwintering as adults of 9% from 1995 and is the highest percentage of adults since 1989 (Figure 4). In previous analysis, the percentage of brood overwintering as adults correlated positively with the density of adults emerging in the spring (Pasek 1996).

Gallery starts remained fairly consistent with what has been found in the past, with an average of 1.8 per 36 sq. in. of bark (Table 1). Over the past 7 years, starts have ranged from 1.8 to 2.3 per 36 sq. in. of bark. This level is still comparable to fifth year populations in Colorado (Lessard and Schmid 1990) and maximum brood production (McMullen and Atkins 1961).

Mean gallery length for all three sites was 27.8 per 36 sq. in. of bark or 111.2 per sq. ft. of bark (Table 1). This density is above the maximum brood production levels of 30-60 in. per sq. ft. of bark (McMullen and Atkins 1961).

Numbers of DFB natural enemies (beetles, wasps, and flies) were lower than for fall 1995 (Table 1). The most natural enemies were collected at the Gravel Pile site, with very few (2 to 3 times less) found at the Sunlight sites.

Mean DBH of sampled trees declined this year to 15.3 in. (Table 1). In 1996, mean DBH was 17.4 in. The only other year that mean DBH was below 20 in. was 1991 when it was 19.1 in. This decrease in diameter of sample trees is indicative of what is happening overall in this area. Most of the largest Douglas-fir have been killed over the course of the outbreak. There is quickly becoming a lack of suitable host trees left for attack and so beetle damage is starting to go down. In effect, the beetles have eaten themselves out of house and home, and so may be ending the outbreak.

A prediction for potential increase in the next generation of beetles is calculated by dividing the mean brood density by twice the mean number of gallery starts. With no further mortality from fall to spring flight, it could be possible for 2.5 times more beetles to emerge next year compared to this year's population. This level of increase is highly unlikely since there will be some mortality of beetles throughout the winter. Even if the number of beetles emerging does increase, there is so little large diameter host material left in this area that the beetles would be attacking smaller trees, resulting in many pitchouts, or have no suitable trees to attack at all. Tree mortality should continue to decline in 1997, although there could still be some large pockets. Overall, even with an indication of stable or increasing beetle numbers, it appears that the Douglas-fir beetle epidemic should be about over due to lack of host material.

Table 1. Douglas-fir beetle overwintering brood production, gallery characteristics and natural enemy numbers per 36 square inches of bark surface of two samples per successfully attacked tree taken at 5-7 feet height in the Clarks Fork Ranger District, Shoshone National Forest, Wyoming, October 1996 (means ± standard deviation).

	Aspect	Gravel Pile	Sunlight East	Sunlight West	All Sites
# Trees		10	7	12	29
DBH		15.0 ± 2.4	15.3 ± 3.5	16.0 ± 3.3	15.3 ± 3.1
Eggs	Both	0.0	0.0	0.0	0.0
Larvae	North	1.1 ± 1.0	2.8 ± 4.4	2.4 ± 3.9	1.9 ± 3.2
	South	0.3 ± 0.5	1.6 ± 3.2	1.4 ± 2.7	1.0 ± 2.3
	Both	0.7 ± 0.9	2.2 ± 3.8	1.4 ± 2.4	1.5 ± 2.8
Pupae	North	0.2 ± 0.6	0.2 ± 0.4	0.2 ± 0.4	0.2 ± 0.5
	South	0.0 ± 0.0	0.2 ± 0.4	0.4 ± 0.6	0.2 ± 0.5
	Both	0.1 ± 0.4	0.2 ± 0.4	0.5 ± 0.7	0.2 ± 0.5
Adults	North	10.2 ± 11.0	3.8 ± 4.0	7.3 ± 10.0	8.3 ± 10.3
	South	4.1 ± 5.6	6.7 ± 11.8	7.7 ± 10.0	6.4 ± 8.8
	Both	7.2 ± 9.0	5.2 ± 8.7	11.4 ± 10.9	7.4 ± 9.5
Total Brood	North	12.5 ± 12.5	6.8 ± 5.6	9.8 ± 10.7	10.6 ± 11.1
	South	4.4 ± 5.7	8.4 ± 14.9	9.5 ± 12.3	7.7 ± 10.7
	Both	8.2 ± 9.4	7.6 ± 11.1	13.2 ± 11.4	9.1 ± 10.9
Gallery Starts	North	2.0 ± 1.5	1.7 ± 0.9	1.7 ± 1.5	1.8 ± 1.2
	South	1.5 ± 1.2	1.9 ± 1.2	2.1 ± 1.0	1.9 ± 1.1
	Both	1.7 ± 1.3	1.8 ± 1.0	2.1 ± 1.0	1.8 ± 1.1
Egg Gallery Length	North	27.9 ± 9.7	24.5 ± 11.1	24.6 ± 10.6	25.8 ± 10.2
	South	30.0 ± 12.9	32.9 ± 12.9	29.9 ± 12.3	29.9 ± 12.3
	Both	29.0 ± 11.2	28.7 ± 12.5	24.8 ± 9.8	27.8 ± 11.4
DFB Enemies: Beetles	North	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
	South	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
	Both	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
DFB Enemies: Wasps	North	4.1 ± 4.0	0.7 ± 1.2	0.6 ± 1.1	1.8 ± 3.0
	South	2.8 ± 3.4	0.6 ± 1.7	0.8 ± 1.6	1.5 ± 2.5
	Both	3.5 ± 3.7	0.6 ± 1.5	0.9 ± 1.2	1.7 ± 2.7
DFB Enemies: Flies	North	1.2 ± 1.7	0.3 ± 0.5	0.8 ± 1.3	0.9 ± 1.4
	South	2.3 ± 3.3	0.8 ± 1.3	0.9 ± 1.3	1.4 ± 2.3
	Both	1.8 ± 2.6	0.5 ± 1.0	1.4 ± 1.6	1.2 ± 1.9

Fig. 1. Douglas-Fir Beetle Emergence by Week of Collection from 14 Trees, each with a 1 X 2 Foot Cage, Clarks Fork RD, Wyoming, 1996

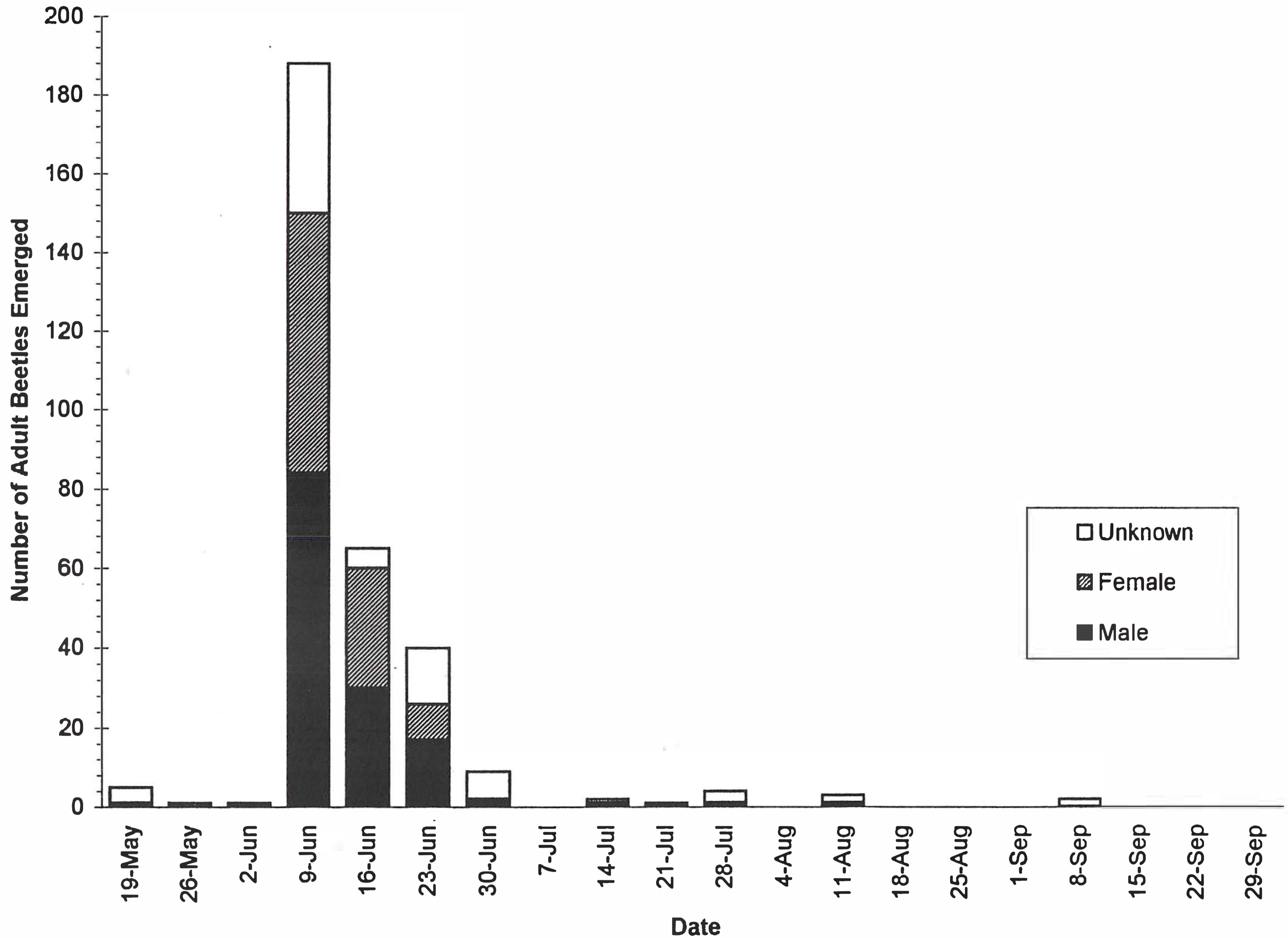
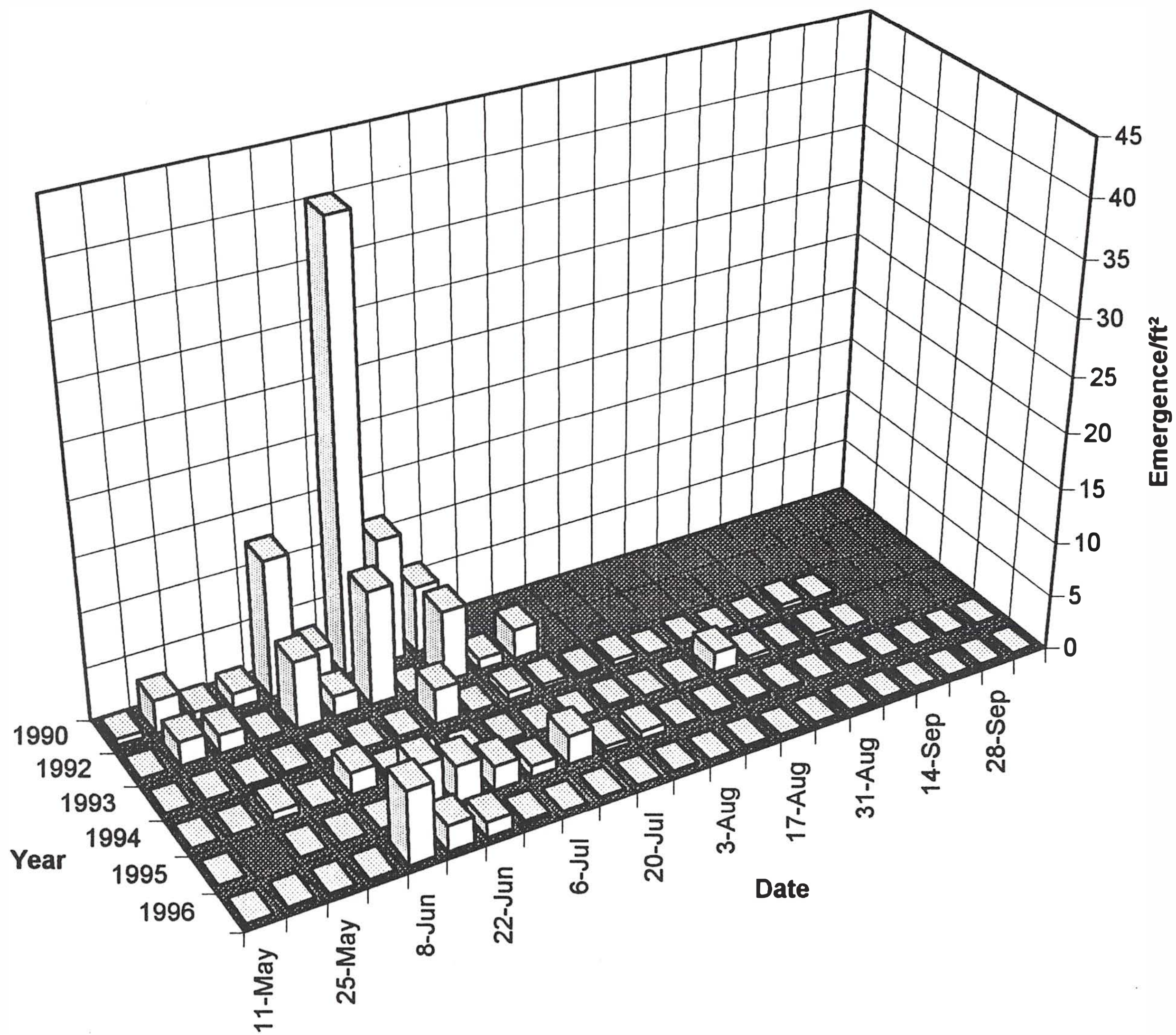


Fig. 2. DFB Emergence by Week, 1990-1996



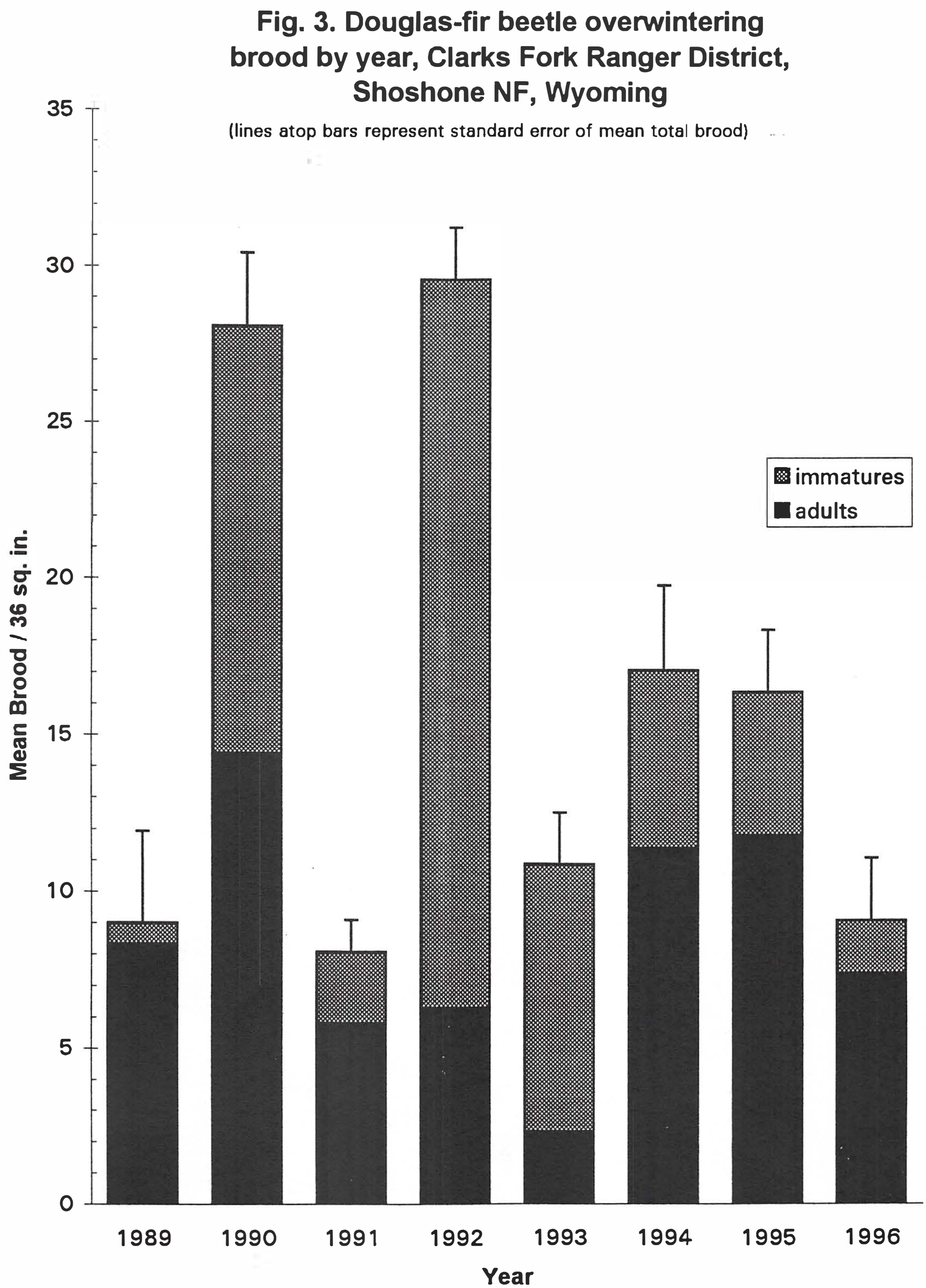
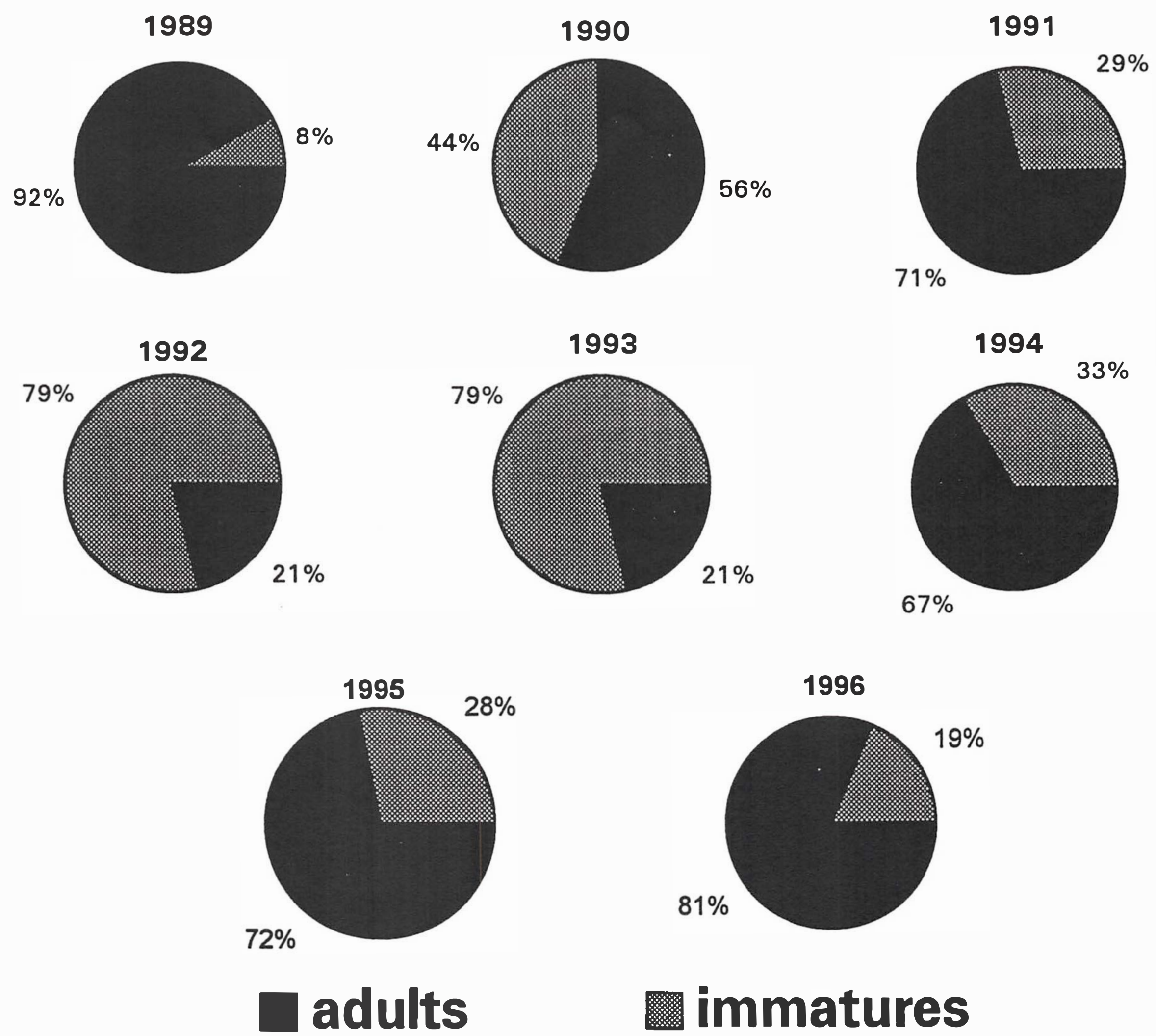


Fig. 3. Douglas-fir beetle overwintering brood by year, Clarks Fork Ranger District, Shoshone NF, Wyoming
(lines atop bars represent standard error of mean total brood)
Mean Brood / 36 sq. in.
35
30
25
20
15
10
5
0
immatures
adults
1989
1990
1991
1992
1993
1994
1995
1996
Year

Fig. 4. Percentages of overwintering adult and immature Douglas-fir beetles from late fall samples of bark taken at 5-7 foot height from successfully attacked trees in the Clarks Fork Ranger District, Shoshone National Forest, Wyoming, for 8 years following the Clover Mist Fire of 1988.



MANAGEMENT ALTERNATIVES

Alternative 1: Salvage/Sanitation Harvests

In stands that have been heavily attacked and mortality has been high, salvaging dead trees to capture some economic value in the near future is appropriate. This will depend on management objectives for each area. In addition, sanitation cuts that remove currently infested trees could be done in conjunction with salvage. Sanitation cuts should be done prior to May 1997, before the beetles start to emerge.

Advantages/Disadvantages: This alternative has the advantage of capturing some economic return from dead and dying trees. It can also reduce possible tree hazards by removing standing dead and dying trees that would be prone to falling. It would also reduce the fuel load in some parts of the outbreak area and can help in getting regeneration started. The disadvantages of this option are that some site disturbance may occur in connection with logging activities and it requires a short implementation time for sanitation.

Alternative 2: Tree Baits

This alternative would need to be used in areas where alternative 1 was employed. In these areas, where logging is planned, tree baits (containing DFB aggregation pheromone) can be attached to standing green trees. This will concentrate beetle attack on these trees which can then be removed along with other trees cut in the area. Trees are baited in May, prior to the beetle flight period, and baited trees then need to be harvested within the following year.

Advantages/Disadvantages: Baiting can pull beetles into areas where salvage/sanitation is being conducted and the infested trees can be removed quickly. This can provide some protection to surrounding areas by pulling attacking beetles to trees scheduled for removal. Baiting does not work when there are large population centers, but there are very few of these left on the Clarks Fork. The disadvantages are that the area must be suitable for harvest and the trees must be removed in a timely fashion, before the beetles emerge from baited trees.

Alternative 3: Silvicultural Treatment

Silvicultural treatments are used in stands that have not been affected by the beetle to reduce susceptibility to attack. It should be part of an ongoing vegetation management program to help increase the health of stands by decreasing their vulnerability to any insects and diseases, not just DFB. To reduce the susceptibility of stands to DFB, basal area should be below 80% of normal stocking (Furniss et al. 1981). Harvesting in old, mature stands, thinning younger stands, and use of prescribed fires could be used to create healthier stand conditions where it is appropriate.

Advantages/Disadvantages: The biggest advantage to this treatment is that it is a preventative measure that can reduce the possibility of large insect caused disturbances from occurring in the future. The biggest disadvantage, at this time, is that it does nothing for the areas that have already been impacted by the DFB. It is also only useful in areas that are suitable for vegetation management activities.

Alternative 4: No Action

The "no action" alternative represents taking no management actions in the DFB impacted area, outside of normal activities. It accepts present and possible future tree mortality as a natural process.

Advantages/Disadvantages: The advantage is that there is no additional activity or site disturbance, such as road building, in areas that have been affected by the DFB. Also, it leaves standing dead trees that can provide habitat for cavity nesting wildlife. The forest is left to recycle and regenerate these areas naturally. The

disadvantages are that there is no commercial value gained from the affected timber, hazardous and downed trees increase in the area, and regeneration can be inhibited.

RECOMMENDATION

In areas that are accessible and where management goals are for some tree harvest, Alternative 1, salvage and sanitation, should be considered. This can regain some economic value from impacted areas, remove some beetle pressure, and enhance regeneration. In areas where this is appropriate, use of tree baits (Alternative 2) could be useful to help remove some of the remaining DFB populations in the area. Alternative 4, silvicultural treatments, is more of a long range, district-wide planning effort to help reduce possible future infestations in stands where vegetation management is practiced. Because of management objectives and inaccessibility, Alternative 4, taking no action, may be necessary.

Forest Health Management will continue to assist in assessing forest health conditions in this area.

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